REMARKS

This Amendment, which is timely with the accompanying Petition for Extension of Time, is submitted under 37 C.F.R. § 1.111, in response to the non-final Office Action mailed December 30, 2004. In the Office Action claims 1 – 6, 8 – 14 and 16 – 23 were rejected under 35 U.S.C. §§ 102 and 103 as being anticipated by or obvious in view of various prior art references, discussed below. In addition, claim 17 was rejected under 35 U.S.C. § 112, second paragraph. Claims 7 and 15 were said to be allowable, but were objected to as being dependent on a rejected base claim. By this amendment corrections have been made to the Specification, claims 1, 5, 7 – 9, 13, 15, 16, 18, 20, 22 and 23 have been amended, claims 2 – 4, 6, 10, 11, 14, 17 and 21 have been cancelled and new claims 24 – 32 have been added. Accordingly, claims 1, 5, 7, 8, 9, 12, 13, 15, 16, 18 – 20 and 22 – 32 are pending. Reexamination and reconsideration in view of the foregoing amendments and following remarks are respectfully requested.

Interview Summary

On April 27, 2005, the undersigned telephoned the examiner to seek clarification concerning the § 112 rejection of claim 17. The examiner acknowledged that claim 17 is in proper format, and that the rejection is incorrect. In the course of the brief discussion, the examiner pointed to claim 22 as being improperly formatted, and the undersigned acknowledged that claim 22 requires correction. Accordingly, this Amendment corrects claim 22 and leaves claim 17 unchanged. The undersigned thanks the examiner for promptly addressing the matter.

Amendments to the Specification

Paragraphs [0027], [0031], [0033] and [0034] have been amended to correct obvious typographical errors. It is believed that these corrections do not require discussion.

A sentence has been added to the end of paragraph [0042] to provide further discussion of the graph of FIG. 6 in view of the additional of certain new claims, as described below. The points made in this new sentence are self evident from the original graph in combination with the original version of the paragraph. No new matter has been added.

Amendments and Additions to the Claims

Independent claim 1 has been amended to incorporate the subject matter of former claims 2 – 4, which have been canceled. In addition, claim 1 now specifies that the gas stream has entrained *abrasive* particles. Support for these changes is found in the original claims and throughout the original Specification.

Claims 5, 13 and 20 have been amended to specify that more than about 90% of the abrasive particles having an aerodynamic diameter of greater than about 2 microns are removed in the low energy venturi scrubber. Support for this new limitation is found, for example, in paragraph [0040] of the original Specification.

Claims 7 and 15, which were said to be allowable, have been rewritten in independent form by incorporating all of the limitations of their respective base claims.

Claim 8 has been amended to be more precise in regard to the relative pressure between the two scrubbing stages. It now specifies that the low pressure venturi operates at less than about half the pressure drop of the second scrubbing stage. Support for this is found, for example, in paragraph [0038] of the Specification, which describes an actual embodiment of the invention wherein the low-pressure venturi was operated in the pressure range of 5" – 10" of water and the second venturi was operated at 18" of water. Thus, the first venturi operated at less than about 50% of the pressure of the second venturi over the entire pressure range of operation.

Independent claim 9 has been amended to incorporate the limitations of claims 10 and 14, which have been canceled.

Independent claim 16 has been amended to incorporate the limitations of claims 17 and 18. Claim 17 has been canceled and claim 18 has been amended to recite a narrower range of droplet size. Support for the narrower range of droplet size now recited in claim 18 is found in paragraph [0043] of the Specification as originally filed.

Claim 22 has been amended by changing the dependency in view of the cancellation of claim 17, and by the elimination of unnecessary language.

Independent claim 23 has been amended to specify that droplets are sprayed into the low energy venturi.

New claim 24 specifies that the droplet generator of claim 23 is a nozzle.

New claim 25 specifies that the droplet generator creates droplets in the same size range specified in several of the method claims as originally filed.

New claims 26, 27 and 28 reduce the upper limit of the droplet size to about 500 microns. Support for this is found in FIG. 6, curve 603, of the application as originally filed. Curve 603 clearly shows that above 500 microns the collection efficiency begins to drop off. It is noted that curve 603 shows nearly 100% collection efficiency, at 500 microns and below. As discussed above, the Specification has been amended to discuss this aspect of FIG. 6, thereby conforming the Specification with these new claims.

New claims 29 and 30 specify that the throat velocity of the low energy venturi is in the range of 50 – 200 fps. Support for this is found, for example, in paragraphs [0014] and [0025] of the application as originally filed.

New claims 31, 32 and 33 specify that the low energy venturi operates at a pressure drop of less than about 5" of water. Support for this is found, for example, in curve 603 of FIG. 6, and the related discussion in paragraph [0042] (as originally filed). Curve 603 displays data acquired at a 5" pressure drop, and shows nearly 100% collection efficiency. In addition, many of the examples discussed in the Specification are at even lower pressure drops.

Argument in Favor of Patentability of the Amended and New Claims

The present invention is generally directed to a two-stage scrubbing system and method wherein the first stage is a low-energy venturi scrubber which uses a spray of droplets to remove large abrasive particles from the effluent flow so that they do not damage the equipment. Applicant recognizes that multi-stage scrubbing systems were known in the prior art, as is reflected, for example, in the references cited by the examiner. It is believed, however, that the problem of efficiently removing large abrasive particles from a gaseous effluent flow was not previously described or addressed in the prior art. This problem differs from the prior art multi-

stage systems which simply use multiple scrubbing stages to obtain good overall particle removal. The present invention is aimed at removing a specific type of particle (*i.e.*, "large" abrasive particles) with maximum efficiency (*i.e.*, low energy and water use). In order to achieve these goals, the present invention, as reflected in the amended and new claims, combine a number of features in a way that is not shown or suggested in the prior art of record.

Turning to a discussion of the references cited by the examiner, Selway (U.S. Pat. No. 3,456,928) discloses a scrubber for a blast furnace. While Selway describes the use of a "central spray nozzle 9" it appears that the primary mechanism of droplet creation is self-atomization. Spray nozzle 9 appears to be primarily for the purpose of "quenching" the gas flow. As in a traditional self-atomization system, water is introduced tangentially along the side walls of the venturi via ducts 11.

It is important to consider that the Selway patent is almost forty years old, dating back prior to the federal Clean Air Act which essentially began the modern regulatory program for air pollution control. The apparatus described is primitive, and the patent is entirely silent as to the level of effluent cleansing that is achieved. Thus, Selway's teachings are ambiguous, at best, because he provides almost no indication of the operational parameters of his system. Saying that a gaseous effluent is "substantially free of solid particles" had quite a different meaning to those skilled in the art forty years ago than it does today. It appears that Selway's goal was to provide an initial stage scrubber that removed as much particulate material as possible, rather than to just remove large abrasive particles, and the patent shows no concern about efficiency.

The venturi scrubber of Calaceto (U.S. Pat. No. 4,460,517) relies entirely on self-atomization to create droplets in the venturi. Thus, in the FIG. 1 embodiment, water is injected via a manifold and "nozzles" that are used to spray water onto the walls of the system. The patent then states: "Gases moving at high velocity atomize the liquid at the throats 24, 25 breaking the liquid into droplets which are of sufficiently small size ..." (See, col. 4, lines 29 – 41.) In the embodiment of FIG. 3, where the throat diameter is larger, a central nozzle may be used to inject additional water by gravity. Again, this embodiment does not use a spray nozzle to create scrubbing droplets, but instead relies on self-atomization. In addition, Calaceto's second

stage scrubber is not a venturi. For example, the patent describes use of a cyclonic separator or an electrostatic precipitator.

Keinänen et al. (U.S. Pat. No. 6,149,715) teaches a multistage scrubbing system using an eductor spray to accelerate gas through the first venturi stage of system – *i.e.*, the liquid is sprayed at a speed which is much higher than the effluent gas speed so as to move the gas through the system (the patent defines this as a "WG" scrubber element – see col. 1, lines 51 – 54). Keinänen et al. then teaches using a second scrubbing stage which uses self atomization, *i.e.*, where the gas flow causes droplet formation (the patent calls this a "GW" scrubber element, *id.*). Thus, as described in the patent, the initial "WG" venturi stage uses much more water than the subsequent "GW" stage. This arrangement is the opposite of what is taught in the present invention. Although the pressure drop in an eductor spray venturi system is often low, due to the fact that the high speed water spray adds substantial energy to the gas flow, such a system is not a low-energy system. A substantial energy input is required to accelerate the gas flow using an eductor spray. Thus, the patent does not teach an initial stage low energy scrubber.

There is no teaching anywhere in the Keinänen et al. patent of spraying water droplets that are optimized to collect particles in a particular size range. There is no teaching or intention to remove large abrasive particles in a pre-cleansing step using a low energy venturi and a relatively small amount of water, such that the large abrasive particles can be separated from the effluent flow and disposed of in a relatively small volume of liquid.

Independent claims 1, 9, 16 and 23, as amended, all specify the use of sprayed droplets in the range of about 200 to about 750 micrometers. None of the prior art teaches spraying droplets in this size range in a first stage, low energy venturi to remove large abrasive particles. As explained, unlike Selway's first stage scrubber (or the first stage scrubbers in the other prior art), which generally attempt to remove as much particulate matter as possible, the first stage scrubber of the present invention is for removing large abrasive particles from the effluent gas flow. The prior art does not teach or suggest using sprayed droplets in the size range recited in the claims of the instant application.

Independent claim 1 (and dependent claims 12 and 19) also specify that the pressure drop across the initial stage low energy venturi is in the range of about 1" to about 10" of water. This

low pressure range is not taught or suggested in Selway or Keinänen et al. Calaceto mentions an embodiment which operates at an 8" pressure drop, but it is submitted that this pressure drop is insufficient to create droplets in the claimed size range by self atomization. (And, of course, because Calaceto relies on self atomization it does not teach introducing a spray of droplets.)

The Office Action states that it would have been obvious to modify the teachings of Keinänen et al. in view of the inventor's own U.S. Pat. No. 6,383,260 ("Schwab"). However, Schwab merely teaches that prior art self-atomizing venturis cannot achieve a droplet size that is smaller than about 500 microns. And, because the droplet size in a self atomization system is inversely related to the pressure drop, only very high energy systems are capable of achieving 500 micron droplets. In any case, the claims have been amended to specify that the droplets are sprayed into the system and, therefore, are not created by self atomization. Therefore, Schwab's teaching about the limits of self atomization systems is irrelevant.

In the Office Action the examiner asserts that given the teachings of the prior art, it would have been obvious to design a system that is most efficient in removing a given particle size. Applicant respectfully disagrees with this assertion. There has been no showing that the prior art teaches the problem solved by the present invention or its solution – namely, using a first stage low energy venturi scrubber that is optimized to remove large abrasive particles and then using a second stage scrubber that is optimized to remove smaller particles.

Claims 5, 13 and 20 require that the first stage venturi removes more than about 90% of the large abrasive particles having an aerodynamic diameter greater than about 2 microns. None of the prior art teaches or suggests this limitation.

Claims 26 – 28 teach that the spray droplets have a mean mass diameter of less than about 500 microns. The claimed combination is not taught or suggested in any of the prior art references.

Claims 29 and 30 teach that the throat velocity of the low energy scrubber is in the range of 50 – 200 fps. The claimed combination is not taught or suggested in any of the prior art references.

Claims 31 – 32 teach that the first stage low energy scrubber has a pressure drop of less than about 5" of water. The claimed combination is not taught or suggested in any of the prior art references.

Conclusion

In view of the amendments and remarks made above, applicant respectfully submits that the application is in condition for allowance and action to that end is respectfully solicited. The examiner is invited to telephone the undersigned at the number listed below if it is believed that a telephone interview would advance the prosecution of this matter.

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Respectfully submitted,

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